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AUTHOR Dockweiler, Clarence J.
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ABSTRACT

The research described is the result of an assessment in grades 4, 5, and 6 of a metric measurement pilot program for grades K-6 in Wheeling, Illinois. The development and administration of metric inventory and attitudinal instruments for teachers and students is described. The report presents four conclusions: (1) there was a significant growth in metric knowledge at all three grade levels; (2) there was a positive effect on the attitude of students toward the metric system; (3) there was no general effect on the students' attitudes toward mathematics; and (4) fourth-grade students had a greater entry knowledge of the objectives for their grade level than fifth- or sixth-grade students. Also included are five recommendations for continued research on and implementation of the program. (MK)

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Texas A&M University
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Title: Analysis of Cognitive and Attitudinal Changes in the Wheeling Metric Project

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Presented by: Clarence J. Dockweiler
Assistant Professor
Texas A&M University
College Station, Texas

Introduction

Implementation of the use of the metric system as the primary system of measurement has been discussed and attempted for a long time. Efforts as long ago as the mid-1800's met with little success (Burton, 1979, p. 28). Although constant references may be found in textbooks of the time, little significant teaching of the metric system occurred. Those early efforts surely contributed to the movement which culminated in the 1970's. On December 23, 1975, President Ford signed the Metric Conversion Act of 1975. This Act provided the United States with a policy regarding the coordination and planning for increased use of the metric system (Metric, 1976, p. 1).

More significant to the study herein described, is the statement issued by the Illinois State Board of Education in April, 1975 as follows:

> Beginning the fiscal year 1976, local education agencies shall begin introduction of the metric system of measurement as the primary language of measurement and the customary system as the secondary language of measurement in Grades K-6, with the metric system of measurement taught exclusively in Grades K-12. (Metric, 1976, p. 1)

The State of Illinois required the metric system in its schools before the voluntary involvement was recommended at the national level.

The official statements set the stage for a serious effort in incorporating the metric system into the curriculum. Surveys indicated that teachers were inadequately prepared and reluctant to begin (Trent, 1978, p. 45 and Fyffe, 1978, p. 643). In the face of this inadequacy and reluctance, but armed with the state mandate, Public School District 21 of Wheeling, Illinois began the development of an ambitious measurement program for K-6.

I. Development of the Program

Prior to the 1978-79 school year, Public School District 21 of Wheeling, Illinois, developed a measurement program for K-6. This extensive pilot program included; statements of objectives for each measurement topic at each grade level, lists of materials needed for the units, suggested sequence and time schedule, and complete lesson plans including worksheets.

To pilot the program the classes of two teachers per grade level were selected. In order to provide some statistical data to aid in the pilot evaluation; an assessment was undertaken at grades 4, 5, and 6. The research described herein is the development and results of that assessment.

II. Development and administration of instruments.

Metric Inventory instruments were developed for teachers, as well as for the students of 4th, 5th, and 6th grades. Due to a concern for time use, the student instruments needed to be short. Objectives at each of the levels were sampled, and 10 item instruments were developed for each grade level. All items were of multiple choice type. The teacher instrument was a 26 item instrument and was designed to measure attainment of objectives at all three grade levels.

Attitudinal instruments were also administered to teachers and students. Two measures of attitude were obtained for each subject. The first was a measure of the subjects' attitude toward mathematics in general; and the second was a measure of the subjects' attitude toward the metric system. The instruments used were adaptations of Osgood's semantic differential techniques as described by Reisman.(Reisman, 1977) The instruments consisted of a series of bipolar adjectives to which subjects were to respond to show how he or she feels about a particular concept. The subjects were to place a mark on a seven-point rating scale to reflect their feeling about the concept as in the example:

Measuring in liters, meters, and grams

Ugly	____	____	____	____	____	____	____	Beautiful
Sad	____	____	____	____	____	____	____	Happy
.								.
.								.
.								.
Unimportant	____	____	____	____	____	____	____	Important

The second attitude measure required the subjects to respond with regard to their feeling toward mathematics generally.

Early in the fall, before instruction in the pilot program, each subject responded to the Metric Inventory and the two attitude measures. After instruction using the pilot program, the same instruments were administered as post-measures. The earliest second administration was after the beginning of the second semester.

Since the Metric Inventory items were referenced to specific objectives and the objectives were sub-grouped by metric topic, it was also possible to analyze the data with regard to the metric topics; length, area, capacity, volume, mass, and temperature and special topics.

III. Discussion, Conclusions, and Recommendations

Of primary interest in this study, is the significance of the observed growth in the metric knowledge of the subjects at each grade level. Of secondary interest is the change in attitudes of the subjects from pretest administration to posttest.

Before considering the significance of the data, observations with regard to the means are appropriate (Table 1). The Pretest means of the Metric Inventory reflect an apparent dramatic drop from a 4th grade mean of

6.33 to a 6th grade mean of 2.14. Since common tests were not administered, across grade level comparisons are difficult, at best. However, an entering mean of 2.14 on the part of 6th graders appears to be quite low, if one can assume that entering knowledge levels from 4th, 5th, and 6th graders are comparable.

Table 1
Table of Means

	Grade		
	4th	5th	6th
Metric Inventory (10 point scale)	n=52	n=44	n=49
Pre-Test	6.33	3.57	2.14
Post-Test	8.71	6.59	4.88
Metric Attitude (60 point scale)			
Pre-Test	49.17	37.91	29.71
Post-Test	51.52	41.68	39.37
Math Attitude (60 point scale)			
Pre-Test	54.17	45.05	46.73
Post-Test	54.85	44.73	45.24

Similarly, Pretest results on the metric attitude scale reflect a substantial difference across grade levels. Since the instruments were constructed with 30 as the focal point, scores above 30 reflect some degree of positive attitude; scores below 30 reflect negative attitude. Therefore, a rather positive pretest result of 49.17 for 4th grade decreases to 29.71 at the 6th grade level. Of possibly greater interest is the apparently dramatic increase in the 6th grade metric attitude from pretest to posttest.

Attitudes toward mathematics generally did not seem to be affected by the program. All levels pretested quite positively and posttest results are similar. The high entry level attitude measure toward mathematics may not have permitted significant growth to occur.

The tests for significance support the observations made regarding the means. The change observed from pretest to posttest on the Metric Inventory was significant for all three grade levels. The only attitude change of significance statistically was a metric attitude change at the 6th grade level. (Table 2).

Table 2
T-test of significance of Growth
from Pre-Test to Post-Test

	Grade		
	4th	5th	6th
Metric Inventory	7.734**	9.598**	7.744**
Metric Attitude	1.436	1.282	3.099*
Math Attitude	.594	.149	.662

* $p<.01$
** $p<.001$

The construction of the Metric Inventory at each grade level permitted the results to be analyzed in terms of sub-topics in the study of the metric system. That is, each test is segmented into subtests of Length, Area, Capacity, Volume, Mass, and Temperature and Special Topics. The only exception to that is the 6th grade instrument which did not include items on Temperature and Special Topics.

Table 3

Percent Correct on Student Subtests of Metric Knowledge

Subtest	Grade					
	4th		5th		6th	
	Pre	Post	Pre	Post	Pre	Post
Length	72.4	91.7	79.5	88.6	30.6	64.3
Area	90.4	92.3	23.3	59.7	22.4	40.8
Capacity	81.4	87.3	18.2	25.0	16.3	52.0
Volume	32.7	67.3	9.1	54.5	21.4	30.6
Mass	52.0	96.1	27.3	75.0	16.3	56.1
Temp and Special Topics	30.1	76.9	50.0	88.6	(not included)	

The percent figures (Table 3) indicate that the 4th grade group had relatively high achievement upon entering the program in three of the six areas. The 5th grade had relatively high entry level for Length only; whereas, the 6th grade was low for all subtests. A word of interpretive caution should be injected due to the small number of items for the subtests. Where only one test item tested an area (i.e., Temp and Special Topics for 5th grade had one item), the interpretation potential is tentative at best. For this reason, percents are reported without attempting to test significance of differences.

Conclusions:

1. The pilot program effected a significant growth in metric knowledge at all three grade levels.
2. The experience has a positive effect on the attitude of students to the metric system, with the most dramatic (and statistically significant) effect occurring at the 6th grade level; the grade of lowest entering metric attitude.

3. Student's attitude toward mathematics as measured by the attitude instruments generally was not affected by the pilot program.
4. Fourth grade students had a greater entry knowledge of objectives written for their grade level than did 5th or 6th grade students of their objectives.

Recommendations:

The following recommendations are made with the assumption that the classrooms selected adequately represent the population of the District. Additional data may need to be gathered to support this assumption.

1. The program should be continued since statistically significant growth for each grade level was accomplished.
2. Differential treatment of sub-topics should be considered. Fourth grades had a relatively high entry level of knowledge for Length, Area, and Volume. Fifth grades had high entry level for Length.
3. Further evaluation should provide a common metric inventory for grades 4, 5, and 6 to permit across grade comparisons.
4. Consider implication of low entry level scores for metric knowledge and metric attitude for grade 6.
5. Since a control group was not identified, conclusions attributing gains to the treatment are tentative. Future research should attempt to identify some type of control. Insignificant gains reported here may have been significant when compared with control group data.

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